OPTICAL DISK DEVICE

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- european:	
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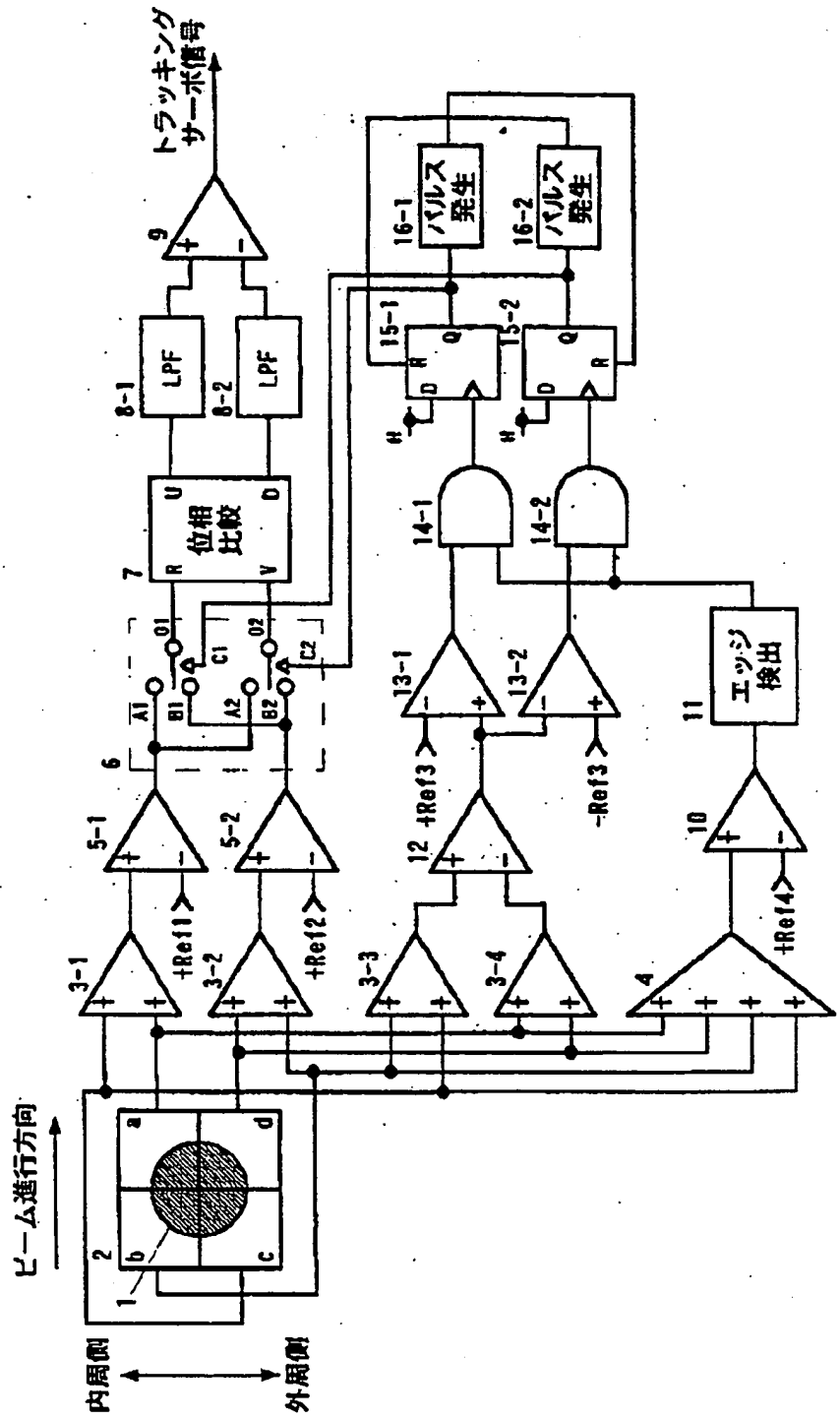
Priority number(s):	

Abstract of **JP2001028134**

PROBLEM TO BE SOLVED: To properly perform tracking servo control even in the case of an optical disk having the pits of different depths by inverting the polarity of a tracking signal for making a pit stream follow a light beam on the basis of the detected result of the depth of the pits.
SOLUTION: When the wavelength of a light beam to be used is defined as &lambda and the refractive index of an optical disk substrate is defined as (n), on the boundary of &lambda /4n, the direction of refraction is inverted. Therefore, with the pit depth of &lambda /4n as the boundary, when pits shallower than this depth and pits deeper than this depth are formed, the polarity of tangential push/pull signal in the case of making the light beam entering or leaving the pit is inverted. Therefore, by observing the polarity of the tangential push/pull signal at the time point of changing the level of an output signal from an adder circuit showing the quantity of reflected light, the pit depth can be judged/detected and proper tracking servo control can be performed regardless of the depth of pits.


トラッキング
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8-1
LPF
8-2
位相
比較
7
U
D
R
V
01
02
C1
C2
A1
B1
A2
B2
6
5-1
5-2
+Ref1
+Ref2
3-1
3-2
3-3
3-4
4
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パルス
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16-2
パルス
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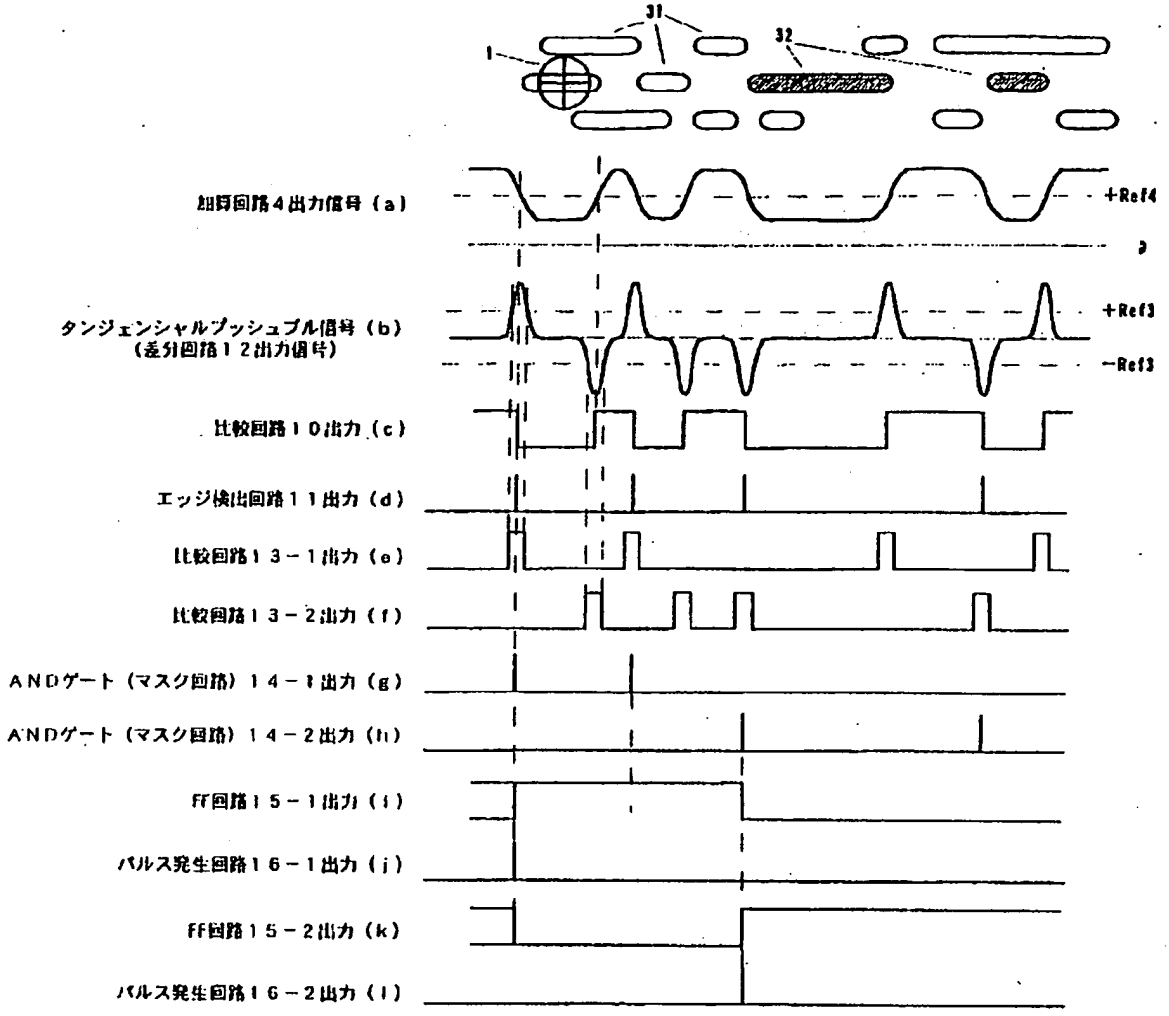
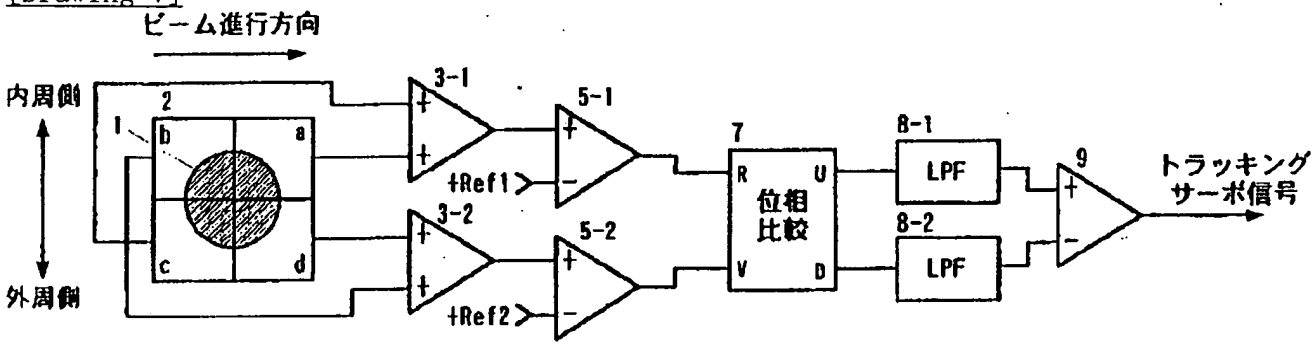
15-1
15-2
14-1
14-2
13-1
13-2
+Ref3
-Ref3
12
11
エッジ
検出
10
+Ref4
ビーム進行方向
a
b
c
d
1
2
内周側
外周側

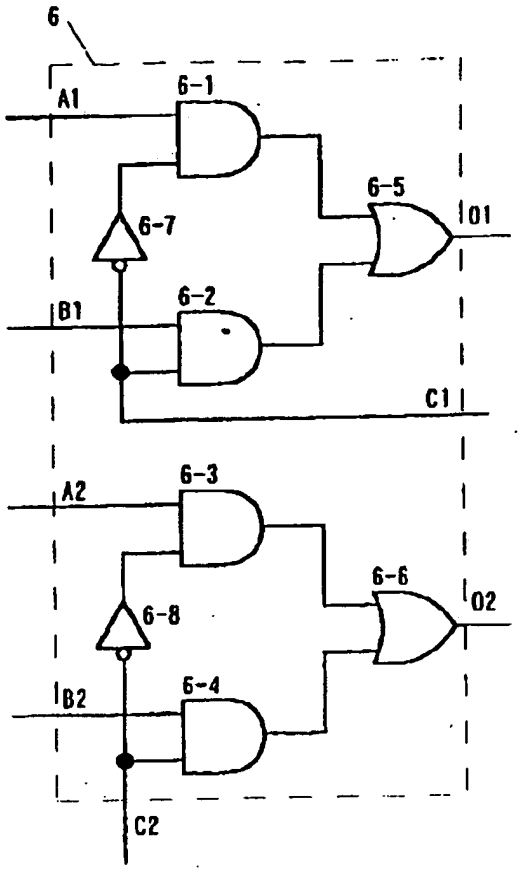
[Drawing 2]



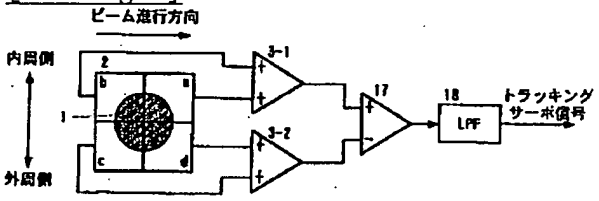
[Drawing 7]



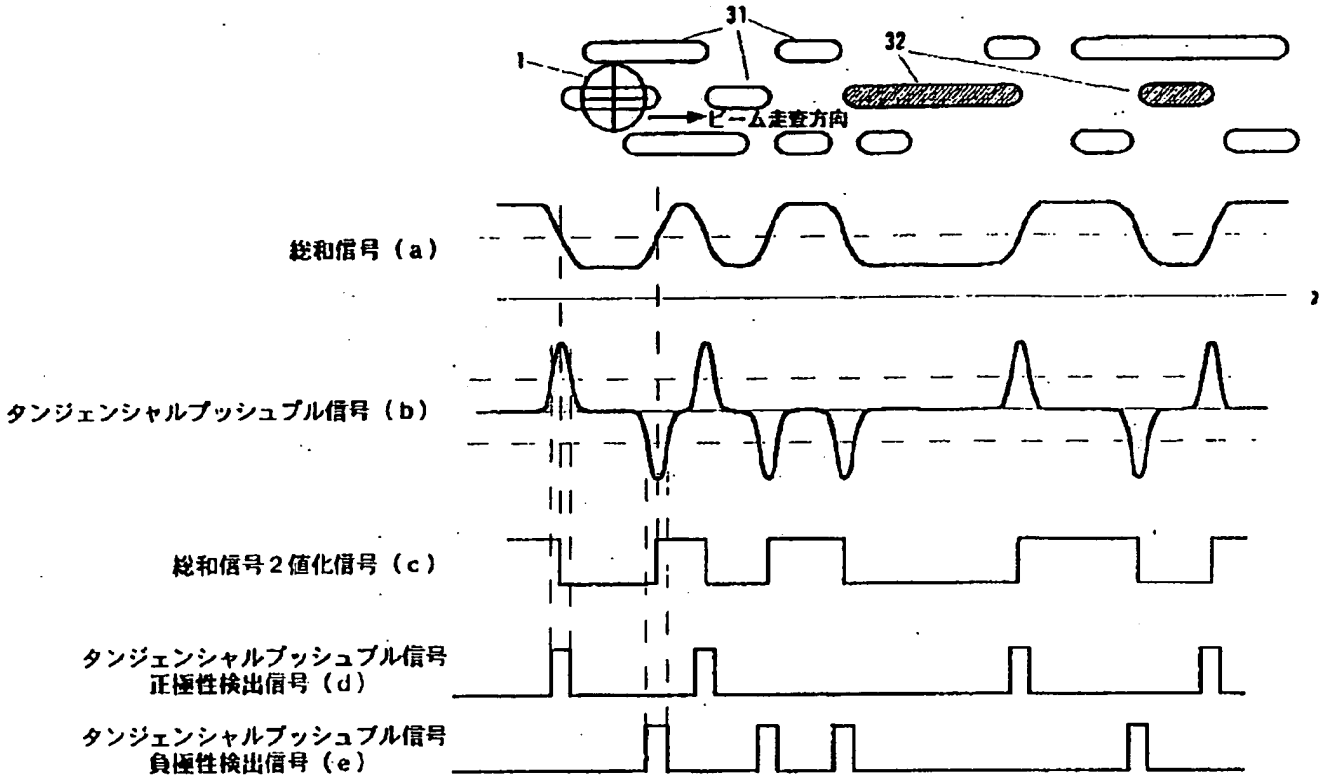
[Drawing 3]



[Drawing 8]



[Drawing 9]


31
32
1
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タンジェンシャルプッシュプル信号（b）
総和信号２値化信号（c）
タンジェンシャルプッシュプル信号
正極性検出信号（d）
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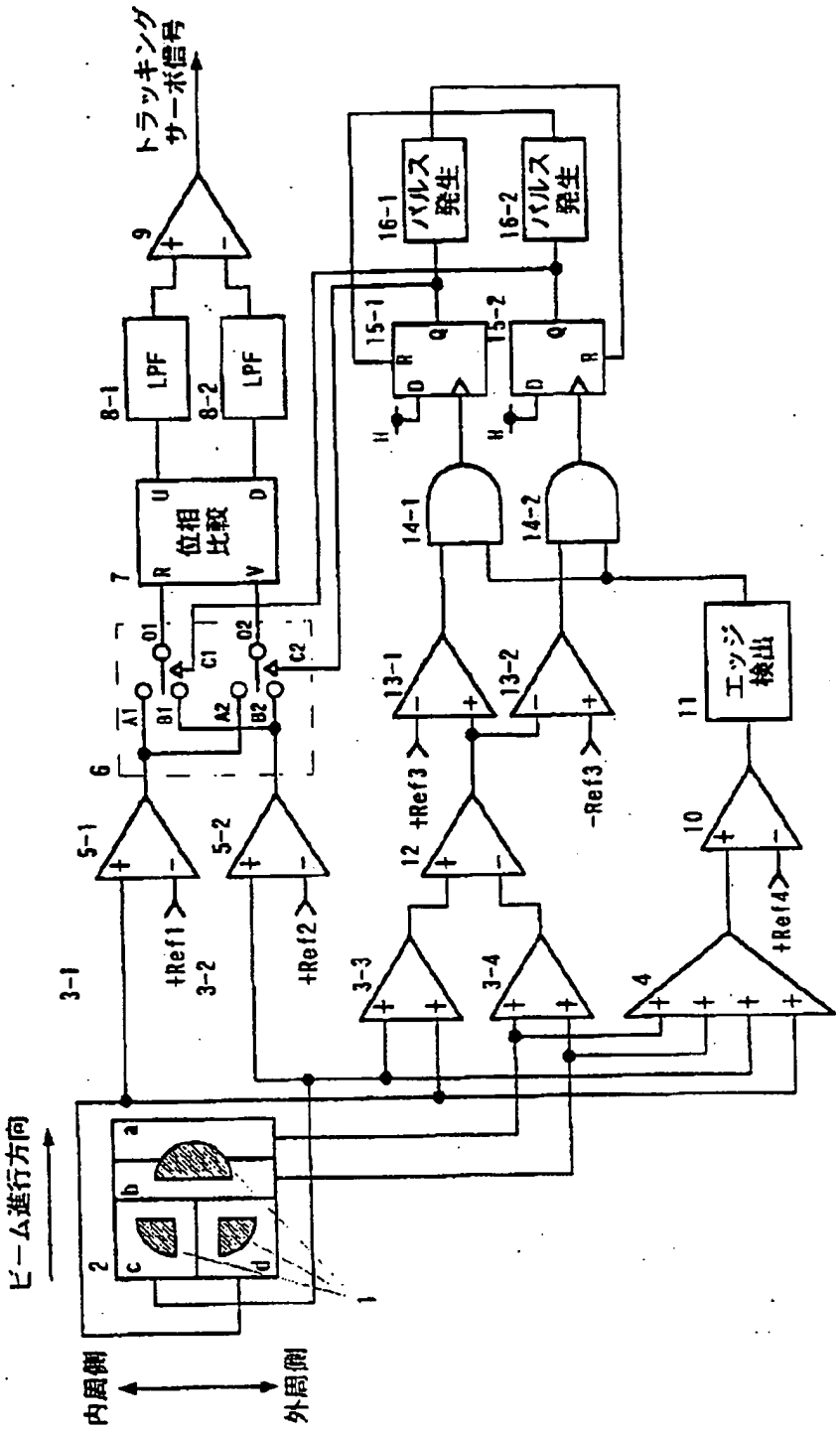
負極性検出信号（e）

[Drawing 4]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8-1
LPF
8-2
位相
比較
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パルス
発生
16-2
パルス
発生
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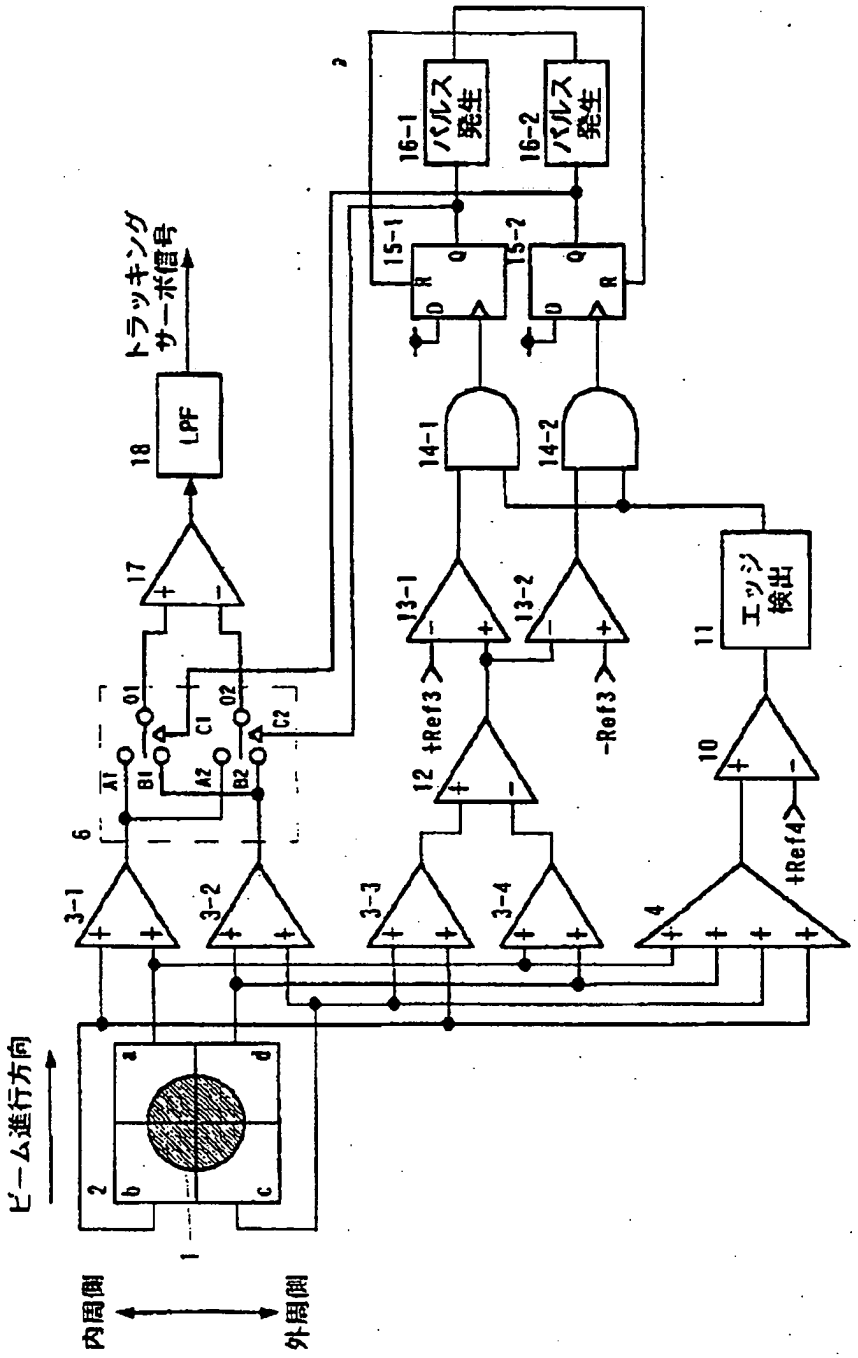
15-2
14-1
14-2
13-1
13-2
エッジ
検出
11
10
+Ref4
12
+Ref3
-Ref3
5-1
5-2
6
+Ref1
+Ref2
3-1
3-2
3-3
3-4
4
ビーム進行方向
内周側
外周側
1
2

[Drawing 5]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15-1
15-2
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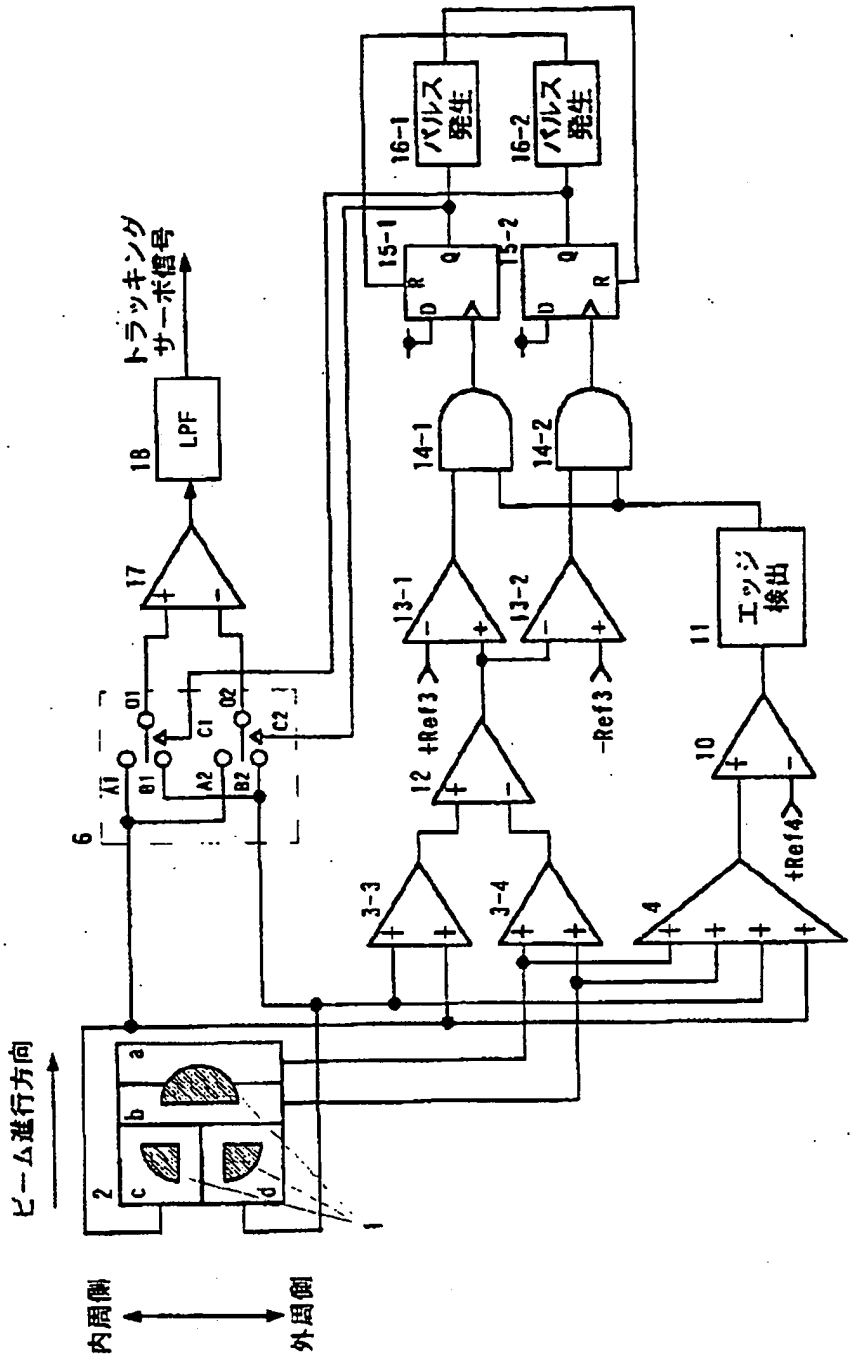
17
14-1
14-2
13-1
13-2
11 エッジ検出
+Ref3
-Ref3
12 +Ref3
10
+Ref4
6
01
02
C1
C2
A1
B1
A2
B2
3-1
3-2
3-3
3-4
4
a
b
c
d
1
2
ビーム進行方向
内周側
外周側

[Drawing 6]



[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the tracking servo of the optical disk unit which uses the optical disc in which information was recorded by the whole surface or the pit which has uneven shape beforehand in part of the recording surface.
[0002]
[Description of the Prior Art]In the optical disk reproducing device for playing the optical disc which has recorded information on the disc face in the pit which has uneven shape beforehand, The tracking servo art for positioning an optical beam to a pit sequence is proposed variously for some time, for example, the indication is made by JP,58-150145,A.
[0003]Drawing 7 is a block lineblock diagram of the tracking servo by a phase contrast (time lag) method, and redraws the composition of a statement on above-mentioned Drawings 3 or 4 of JP,58-150145,A.
[0004]A phase contrast (time lag) method receives the reflected light beam from an optical disc in the photodetector which has four elements in the radial direction and tangential direction of an optical disc, The sum signal of the output of what is located in a vertical angle among these photodetectors is searched for, the phase contrast (time lag) of the sum signal is detected, and tracking is performed. In drawing 7, the catoptric light from a disk was condensed to the photodetector 2, it has entered into it, and each portion outputs the signal according to the light volume which entered. The summing amplifier 3-1 and 3-2 are outputted to the comparator (comparison circuit) 5-1 and 5-2 in quest of the sum signal of the portions a and c and b which are located in a vertical angle among the photodetectors 2, and d. The comparator 5-1 and 5-2 compare the output signal of reference signal +Ref1, +Ref2, and the summing amplifier 3-1 and 3-2, and output the binary-ized signal which is the result.
[0005]In order that the catoptric light of an optical beam may receive diffraction by a pit, the intensity distribution on the photodetector of catoptric light is changed in time according to an optical beam and the physical relationship of pit each. For example, when the optical beam follows right above a pit sequence, the sum signal of the output of the element (a+c) and each (b+d) which it has in the diagonal position of the photodetector on a pit carries out the comparator 5-1 and change same to the same timing as the output signal of 5-2 in order to carry out

the same change. When the optical beam follows the position [right above / a pit sequence] shifted, according to the direction of a gap, either changes previously the phase contrast [sum signal / of the output of the above (a+c) and each (b+d)] (time lag) according to the amount of gaps.

[0006]Therefore, detect the phase contrast (time lag) between the comparator 5-1 and the output signal of 5-2 in the phase comparison circuit 7, and the pulse according to the above-mentioned phase contrast (time lag) is made to output, The tracking signal which shows the amount of gaps and direction of an optical beam and a pit sequence can be acquired by only a low-frequency component's extracting this pulse by LPF(low pass filter)8-1 and 8-2, and searching for that difference in the difference circuit 9.

[0007]There is the push pull method as an example of another art for acquiring a tracking servo signal.

[0008]The push pull method is the method of making this a tracking signal in quest of the light volume difference by the side of the inner circumference of the reflected light beam divided into the tangential direction, and a periphery, and the example of the block lineblock diagram for generating the tracking servo signal by the push pull method is shown in drawing 8.

[0009]according to both physical relationship, if it irradiates with an optical beam on a pit sequence, although a pit receives diffraction, by the push pull method, in the inner circumference side of an optical disc, and the direction of the periphery each sides, the catoptric light will be carried out for 2 minutes, and the catoptric light will detect it, and will generate a tracking servo signal based on the average intensity.

[0010]Although it is the same as that of a previous phase contrast (time lag) method to be condensed in drawing 8 on the photodetector by which catoptric light was quadrisected, The adder circuit 3-1 and 3-2 are not the elements located in the vertical angle of a photodetector, add the output signal of each element located in the inner circumference and periphery side, and output the added result to the difference circuit 17. The difference circuit 17 outputs these adder circuits 3-1 and the difference result of 3-two to two signals to LPF18, The principle of the push pull method obtains what removed the ingredient which is the high frequency which each pit has from the difference result, and extracted the low-pass ingredient and the signal component which in other words is equivalent to a little average gap of an optical beam and a pit sequence as a tracking servo signal.

[0011]

[Problem(s) to be Solved by the Invention]Although the pit (mark) long record which includes information in the length simultaneously with a pit or the existence of a mark is generally used in the present optical disc, if information is also given to the depth of a pit, record of further mass information can be expected. These people have already applied for this as Japanese Patent Application No. No. 184604 [11 to].

[0012]although it is art, with this art, the diffraction pattern by interference of the light produced in the pit which has uneven shape includes new information using changing with depth of a pit.

[0013]Drawing 9 is a mimetic diagram showing the reproduction principle of the information recorded by pit depth. The depth of the pit 32 where, as for the pit

31, the depth expressed the wavelength of light with the comparatively shallow pit which is a grade (lambda/6n) of the following (lambda/4n), and the slash when the refractive index of lambda and an optical disk substrate was set to n is a comparatively deep pit of a grade (lambda/3n) exceeding (lambda/4n). When these pit sequences are scanned in the direction of the arrow in a figure in an optical beam, a difference clear at the time of being located on the time of an optical beam being located on the pit 31 and the pit 32 does not have a sum signal (a) of the incident light quantity to a photodetector. Namely, it is better for the information by the sum signal of light volume not to have great difference in the depth of a pit, and for it to be more desirable for a difference to seldom arise in pit depth in the sum signal of light volume, and not to give this information with pit depth, since reproduction of the information where the direction which has change of clear light volume by the existence of a pit rather was stabilized is possible.

[0014]However, if the signal and tangential push pull signal (b) which divided catoptric light into the order half part in the direction of movement of the optical beam, and searched for the light volume difference are observed, The polarity of the pulse form signal generated when an optical beam approaches on a pit or escapes is reversed according to the difference of the diffraction pattern of the light resulting from the depth of a pit. Change of the sum signal according [this] to the existence of a pit is the separate phenomenon which completely became independent.

[0015]Therefore, if the polarity of this tangential push pull signal is detected, only by the length and existence of a pit, there will be nothing and it will become possible to include new information also in the depth of a pit. This is a gist of above-mentioned Japanese Patent Application No. No. 184604 [11 to] for which these people already applied.

[0016]However, saying that the polarity of a tangential push pull signal is reversed with pit depth is saying that the diffraction pattern of catoptric light changes in the depth of a pit. Therefore, by the phase contrast method or the push pull method for using the intensity distribution by the diffraction pattern of catoptric light, the polarity of a tracking signal may be reversed in a deep pit and a shallow pit, and tracking servo control cannot be correctly performed by the conventional methods, such as a phase contrast method and the push pull method.

[0017]This invention provides the art in which tracking servo control can be correctly performed also in the optical disc which has the above pits where the depth differs.

[0018]

[Means for Solving the Problem]In order to solve the above-mentioned technical problem, this invention provided the following means.

[0019]Namely, an optical disc which has the part which recorded information by a pit is used for the 1st means, and. It has a pit depth detection means to detect the depth of said pit, and a polarity-reversals means to reverse the polarity of a tracking signal for making an optical beam follow a pit sequence based on an output of said pit depth detection means.

[0020]In an optical disk unit of the 1st means, the 2nd means said pit depth detection means, Based on a signal according to light volume of catoptric light of an optical beam with which said pit was irradiated, and a signal according to a

difference of intensity distribution in a tangential direction of said pit sequence, Based on the polarity of a signal according to a difference of said intensity distribution in a change point of a signal according to light volume of said catoptric light, it is characterized by detecting the depth of said pit.

[0021]In an optical disk unit of the 1st means or the 2nd means, the 3rd means said pit depth detection means, The 1st and the 2nd comparison means of binary-izing a signal according to a difference of intensity distribution which can be put on said tangential direction as compared with two reference values, a signal according to light volume of said catoptric light -- it is characterized by detecting the depth of a pit with reference to an output of the above 1st and the 2nd comparison means based on the reference result in change timing of an output of 3rd comparison means to binary-ize as compared with another reference value, and a comparison means of the above 3rd.

[0022]The 4th means receives catoptric light of an optical beam with which said pit was irradiated with a photo detector in an optical disk unit of the 1st means, Detect phase contrast of an output signal from the photo detector by a phase difference detecting means, and a tracking signal is generated, and it is characterized by changing the polarity of a tracking signal according to a detection result of said pit depth detection means.

[0023]Catoptric light of an optical beam which irradiated said pit with the 5th means in an optical disk unit of the 1st means, Receive a difference of intensity distribution which can set said optical disc radially with a photo detector, and a difference means generates a tracking signal based on intensity difference of an output signal from the photo detector, and it is characterized by changing the polarity of a tracking signal according to a detection result of said pit depth detection means.

[0024]moreover -- setting the 6th means to an optical disk unit of the 4th means or the 5th means -- said photo detector -- a tangential direction of a sequence of said pit of catoptric light of said optical beam, and a radial direction of said optical disc -- respectively -- abbreviation -- it is characterized by having the arrangement which can detect intensity distribution of a parallel direction.

[0025]The 7th means is characterized by arranging said photo detector at approximately "character of rice field" shape in an optical disk unit of the 6th means.

[0026]moreover -- setting the 8th means to an optical disk unit of the 6th means -- said photo detector -- a radial direction of said optical disc -- abbreviated -- it is characterized by arranging an element which can detect parallel intensity distribution, and an element which is not detected.

[0027]When a refractive index of a substrate of lambda and an optical disc is set to n and the 9th means sets arbitrary integers to k and m for wavelength of light of said optical beam in an optical disk unit of the 1st means, The depth of a pit formed in the shape of [to be used] an optical disc is characterized by being classified for any of D1 and D2 which fulfill conditions of <(klambda/2n) D1< {(lambda/4n) + (klambda/2n)} and {(lambda/4n) +(mlambda/2n)} <D2< {(m+1) -lambda/2n} being.

[0028]The 10th means is characterized by setting at least one side of k of said integer, and m to 0 in an optical disk unit of the 9th means.

[0029]The 11th means is characterized by including information in the depth of

said pit in an optical disk unit of the 10th means.
[0030]In an optical disk unit of the 1st, the 9th, or the 10th means the 12th means, When equipped with a recorded type optical disc which forms a recording mark which irradiates with light, and from which reflectance differs, it is characterized by choosing the depth of a pit of an optical disc so that the polarity of said tracking signal over this may turn into polarity which produces a tracking servo blank.
[0031]
[Embodiment of the Invention][Embodiment 1] One example of this invention is described using drawing 1 thru/or drawing 6.
[0032]Drawing 1 is a block diagram of a main part at the time of applying this invention to generation of a tracking signal to the optical disk unit which uses what is called a phase contrast method.
[0033]It is condensed, the catoptric light from an optical disc enters into the photodetector 2, and the photodetector 2 outputs the signal proportional to each incident light quantity. This photodetector serves as suitable arrangement which divides catoptric light in the two directions of the direction of movement of an optical beam, the tangential direction of the pit sequence which in other words is formed on the optical disc, and the radial direction of an optical disc.
[0034]The adder circuit 3-3 and 3-4 output the sum signal of the output from the adder circuit 3-1, the portions a and c to which 3-2 is located in the vertical angle of this photodetector 2, b, and d, and a and d of the direction of movement of an optical beam, and the direction of movement of an optical beam output the sum signal of the output from b and c of an opposite direction.
[0035]The adder circuit 4 is outputted in quest of total of the output of the photodetector 2. The adder circuit 3-1 and the output of 3-2 are measured with the comparator 5-1, reference voltage +Ref1 which were beforehand set up in 5-2, and +Ref2, respectively, and the binary-ized signal which is the comparison result is inputted into the selection circuitry 6.
[0036]The output signal of the FF circuit which changes into R of the phase comparison circuit 7 and any of V input terminal the switch (selection circuitry) 6 inputs the above-mentioned comparator 5-1 and the output of 5-2, and mentions it later performs this change.
[0037]The phase comparison circuit 7 measures R input and V input, and outputs the pulse of the width according to the phase contrast between both according to whether which the phase contrast is progressing. For example, in this example, when V input is behind compared with R input, when V input is progressing conversely, the pulse of the width according to that delaying amount shall be outputted from D output from U output.
[0038]U output signal and D output signal of the phase comparison circuit 7, Only a low-pass ingredient is extracted by LPF8-1 and 8-2, respectively, it is inputted into the difference circuit 9, and the difference circuit 9 outputs the difference of the difference of the outputs of LPF8-1 and 8-2, i.e., the low-pass ingredient of the output of the phase comparison circuit 7, as a tracking signal.
[0039]Although the output of the adder circuit 4 which asks for total of the output signal from the photodetector 2 is compared with reference voltage +Ref4 by the comparator (comparison circuit) 10 on the other hand and it is a binary-ized signal which is the result, and a signal with which the size of the reflected

light quantity by the existence of a pit is expressed if it puts in another way, This is inputted into the edge detection circuit 11. The edge detection circuit 11 outputs a pulse by the falling edge corresponding to transition of a non-pit -> pit in drawing 1 among the standup and falling edge of the output signal of the comparator 10.

[0040]The adder circuit 3-3 and the output of 3-4 which asked for the output of the element located in a cross direction about the direction of movement of an optical beam among the elements of the photodetector 2, respectively are inputted into the difference circuit 12. Since the output of this difference circuit 2 is a signal which shows the intensity distribution difference of the direction of a pit sequence tangent (Tangent) of catoptric light, it is called a tangential push pull signal and this is inputted into the comparator (comparison circuit) 13-1 and 13-2. The comparator 13-1 is beforehand set to a tangential push pull signal, and is compared with reference voltage +Ref3, When a tangential push pull signal is larger than +Ref3, while outputting "H", The comparator 13-2 is beforehand set to a tangential push pull signal, and as compared with reference voltage-Ref3, when a tangential push pull signal is smaller than -Ref3, it outputs "H".

[0041]The comparator 13-1 and the output of 13-2 are connected to AND gate (mask circuit) 14-1 and the input terminal of 14-2 which is one side, respectively, and the output of the edge detection circuit 11 is connected to another [AND gate 14-1 and] input terminals of both of 14-2.

[0042]Therefore, AND gate 14-1 and 14-2 will output a pulse according to whether the comparator 13-1 and which output of 13-2 are "H", respectively, when a pulse is outputted from the output of the edge detection circuit 11.

[0043]If a view is changed, these AND gates 14-1 and 14-2, It is also possible to say that the reflected-light-quantity signal which are the comparator 13-1 and an output of 13-2 and which is an output of the edge detection circuit 11 about what binary-ized the tangential push pull signal is referred to and outputted in the change point of what was binary-ized.

[0044]Or even if the comparator 13-1 and 13-2 generate an output, except the specific timing to which the edge detection circuit 11 generates a pulse, it can also be said that the mask of this is carried out and it is serving not to output.

[0045]AND gate 14-1 and the output of 14-2 are connected to FF circuit 15-1 and the clocked into of 15-2. Since the D input is connected to "H" level, if a pulse is inputted into clocked into, an output will become "H", and FF circuit 15-1 and 15-2 are connection that an output is set to "L", if a pulse is inputted into a reset terminal.

[0046]On the other hand to the reset terminal of FF circuit 15-1, the output of the pulse generating circuit 15-2 which generates a pulse in the standup of the output Q of FF circuit 15-2, Since the output of the pulse generating circuit 15-1 which generates a pulse in the standup of the output Q of FF circuit 15-1 is connected to the reset terminal of FF circuit 15-2, above-mentioned FF circuit 15-1 or 15-2 -- if which output Q rises, and also if a pulse will be outputted to FF circuit 15-1 and 15-2, respectively from AND gate circuit 14-1 or 14-2 if it puts in another way, it has composition which resets the FF circuit of another side.

[0047]FF circuit 15-1 and the output Q of 15-2 are connected to the control

terminal C1 of the switch 6, and C2, respectively, When the output of an FF circuit is [the output of an FF circuit] "L" in "H", the terminal O1 of the switch 6 is connected to A1 side, O2 is connected to the B-2 side, respectively, and the output of the comparator 5-2 chooses to R input of the phase comparison circuit 7, and is connected to the output of the comparator 5-1, and V input to it. Conversely, when a state is reversed and the output of an FF circuit is [the output of "L" and an FF circuit] "H", The terminal O1 of the switch 6 is connected to B1 side, O2 is connected to A2 side, and it has the composition that the output of the comparator 5-1 is chosen, to the output of the comparator 5-2, and V input to R input of the phase comparison circuit 7.

[0048]As already stated, the phase comparison circuit 7 compares the phase contrast of R input and V input, and since it is what outputs the pulse according to the direction and quantity of the progress delay, if R input and V input are replaced, the terminal which outputs a pulse will interchange.

[0049]Therefore, if FF circuit 15-1 and the state of the output Q of 15-2 change, the polarity of the tracking signal which is an output of the difference circuit 9 will be reversed.

[0050]Subsequently, in the optical disc which has a pit where the depth differs, the waveform of each part of drawing 1 and timing at the time of an optical beam following the pit sequence top, and going are explained using drawing 2.

[0051]32 to which 31 performed the pit where the depth is comparatively shallow, and hatching is a comparatively deep pit among drawing 2. When the optical beam 1 follows a these top and goes, an optical beam takes for coming to a pit, a level falls, a large and small level variation is carried out according to the existence of a pit, and it increases [the output signal (a) showing the reflected light quantity of the adder circuit 4 is taken for slipping out, and].

[0052]On the other hand, the tangential push pull signal (b) which is an output of the difference circuit 12, Since the difference of the intensity distribution of the catoptric light of an optical beam in the tangential direction of a pit sequence is searched for as point **, When it is in the situation where the first portion to a direction of movement and the latter half part of an optical beam differ from each other, an optical beam comes to a pit, or slipping out etc. more specifically becomes a pulse form signal which has reverse polarity, respectively, when located near pit order edge.

[0053]By the way, the intensity distribution of the catoptric light from a pit is the result of being influenced by diffraction by the pit of an optical beam, and when the refractive index of lambda and an optical disk substrate is set to n for the wavelength of the light (optical beam) used especially, the direction of diffraction is reversed bordering on (lambda/4n).

[0054]For this reason, if the deep thing in which the depth of a pit exceeds this with the shallow thing below this bordering on the above (lambda/4n) is formed, the polarity of the tangential push pull signal at the time of an optical beam coming to a pit or slipping out will be reversed.

[0055]Therefore, if the polarity of the tangential push pull signal (b) at the time of changing the level of the output signal (a) of the adder circuit 4 which shows the above-mentioned reflected light quantity is observed, Pit depth can be judged and detected, if processing which reverses the polarity of a tracking signal based on this is performed, it will not be based on the depth of a pit but

right tracking servo control can be performed. This is a fundamental view of this invention.

[0056]It is good also as detecting the depth of a pit from a tangential push pull signal etc. simultaneously, giving another meaning to a deep pit by the difference, for example, raising storage density or giving additional information etc. even if the change of tracking servo signal polarity by this invention is effective and that from which pit depth differs is intermingled also to such an optical disc, tracking flattery can be performed correctly -- the above -- additional information etc. are exactly renewable.

[0057]When an optical beam comes to the shallow pit 31 in drawing 2, it becomes positive, and when slipping out, it serves as negative, and the tangential push pull signal (b) is shown about the deep pit 32 as what carries out change contrary to this. Of course, even if this relation is reverse, as long as it changes some connection of a circuit, etc., it may be what can respond easily.

[0058]It returns to drawing 2 and explanation of operation is continued. It is (c which binary-ized the output signal (a) of the previous adder circuit 4 by reference voltage +Ref4 with the comparator 10), and this is not the depth of a pit and considers the level variation of "L" as "H" according to the existence. The neighborhood of edge of a pit carries out the level variation, and when falling of (c), i.e., an optical beam, comes to a pit here, a pulse signal (d) is outputted in the edge detection circuit 11.

[0059]On the other hand, a tangential push pull signal (b) is compared with +Ref3 which are the comparator 13-1 and a reference value which is different by 13-2, respectively, and -Ref3, and turns into a binary-ized signal shown in (e) and (f). Although logical products with (d) which is an output of these and the edge detection circuit 11 are AND gate 14-1, an output (g) of 14-2, and (h), Since the output of the comparator 13-1 serves as "H" level when the output pulse (d) of the edge detection circuit 11 occurs in a shallow pit, a pulse occurs in the output (g) of AND gate 14-1, and let the output Q of FF circuit 15-1 be "H" level. Conversely, since the output of the comparator 13-2 serves as "H" level when the output pulse (d) of the edge detection circuit 11 occurs in the case of a deep pit, a pulse occurs in the output (g) of AND gate 14-2, and let the output Q of FF circuit 15-2 be "H" level.

[0060]And since the switch 6 changes with FF circuit 15-1 and the output Q of 15-2 and the input signal to the phase comparison circuit 7 is changed as above-mentioned, a change is automatically performed so that the polarity of a tracking servo signal may become suitable according to pit depth.

[0061]Although the switch (selection circuitry) 6 is considered as the composition which changes the input of the phase comparison circuit 7 in drawing 1, This can be inserted between U and the D connector which are the outputs of the phase comparison circuit 7, LPF8-1, and 8-2, and the polarity of a tracking servo signal can be similarly changed as composition which changes the output of the phase comparison circuit 7.

[0062]Or phase comparison circuit 7 the very thing has 2 sets of circuits which detect the phase contrast of for example, R input and V input, In being with composition whose another side one of the two detects the progress delay in V input on the basis of R input, and detects the progress delay in R input on the basis of V input etc., operation of the phase comparison circuit 7 may be directly

changed in order to operate only one of these using FF circuit 15-1 and the output Q of 15-2.

[0063]Or the composition which inserts the switch 6 between LPF8-1, 8-2, and the difference circuit 9, and changes the polarity of a tracking servo signal here, It may be the composition which forms separately the inverting amplifier which reverses the output of the difference circuit 9, chooses any of the output of the difference circuit 9 and this inverting amplifier they are, and is made into a tracking servo signal.

[0064]Since the switch 6 is composition which chooses and outputs the comparator 5-1 and the binary-ized (digital) signal which is the outputs from 5-2 in drawing 1, You may constitute from AND gate 6-1 as shown in drawing 3 thru/or 6-4, OR gate 6-5 and 6-6, the inverter 6-7, and 6-8.

[0065]While omitting AND gate 14-1 and 14-2 in drawing 1 and applying the output of the edge detection circuit 11 to FF circuit 15-1 and the clocked into of 15-2 directly, The same operation can be obtained, even if there is nothing at "H" level immobilization and D input of FF circuit 15-1 is connected to the output of the comparator 13-1, and there is also no D input of FF circuit 15-2 at "H" level immobilization and it connects it to the output of the comparator 13-2.

[0066]Or even if it is not falling of the output of the comparator 10 about operation of the edge detection circuit 11 and outputs a pulse in a standup, Even if it generates a pulse in both a standup and falling, it is possible to obtain the thing of composition of to change the polarity of a tracking servo signal automatically according to pit depth in a similar manner by some circuit alterations.

[0067]In each element in this example, if the element output of each photodetector is binary-ized through a comparator, most will be advanced by processing of this binary-ized signal after that. The comparator 13-1 especially about a tangential push pull signal, 13-2, and the comparator 10 or subsequent ones about the sum signal of light volume. Digital-IC-izing is possible and integration is easy also until it results in the switch 6, when it has a part which detects the depth of a pit until it results in control of the switch 6, or composition as shows drawing 3 the switch 6.

[0068]Although the tracking servo signal is generated by the phase contrast method in this example, When this phase contrast method makes an optical beam follow a pit sequence with the big optical disc of eccentricity, etc., Since the phase difference detection after binary-izing the signal from a photodetector to a tracking servo signal in addition to the advantage referred to as being hard to produce offset can be processed in a digital circuit even if the object lens which makes an optical beam condense is displaced greatly,. there is an advantage further also in respect of integration of a circuit.

[0069]in addition -- if the photodetector 2 is observed -- this example -- the tangential direction of the inside of the catoptric light of an optical beam, and a pit sequence, and the radial direction of an optical disc -- respectively -- abbreviation -- the element is arranged so that parallel intensity distribution may be detected. For this reason, from the output of a photodetector, both a tangential push pull signal a push pull signal and the signal equivalent to total of reflected light quantity are generable based on the intensity distribution of that catoptric light.

[0070]If reference is made, arrangement of the element will be an abbreviated "character of rice field" mold. Since this abbreviated "character of rice field" mold photodetector is conventionally used abundantly at the optical pickup of an optical disk unit, generation of the focus error signal what is called by astigmatic method is also possible, and. The advantage in this invention referred to as detecting pit depth and being able to change the polarity of a tracking servo signal automatically can be enjoyed collectively, using without adding a new element to a certain optical pickup from the former.
[0071]By the way, if the depth of a pit is one kind like the conventional optical disc as already stated, Since it becomes constant [the polarity of change of the tangential push pull signal (b) accompanying change of the level of the output signal (a) of the adder circuit 4 which can also be said to be the sum signal of reflected light quantity], The polarity of a tracking servo signal is fixed to a thing suitable for the pit depth, and compatibility with the conventional optical disc is maintained.
[0072]Or it is not a pit and a tangential push pull signal can also be acquired as well as the sum signal of reflected light quantity also in the optical disc of the record type which forms the recording mark from which reflectance differs by the exposure of light. When an optical beam comes to a recording mark and it slips out of this again, it is for an intensity distribution difference to arise in the cross direction of the direction of movement of an optical beam of catoptric light.
[0073]Under the present circumstances, it becomes constant [change of the polarity of a tangential push pull signal] with the reflectance of a recording mark, therefore the polarity of a tracking servo signal is fixed, and reproduction of the information by a recording mark can also be performed normally.
[0074]However, since the depth information of a pit cannot be copied although only the information by total of reflected light quantity can be copied if the contents of the optical disc which gave information to the depth of the pit are copied to a such record type optical disc, the copy of the information given to pit depth is prevented.
[0075]Or with the optical disc of the record type which forms the recording mark from which reflectance differs, adjusting pit depth using the polarity of a tracking servo signal being fixed, so that the polarity of a tracking servo signal may be fixed to polarity contrary to this is also considered. In this case, in the optical disc on which information was recorded in the pit, although tracking servo control is surely possible, Since the polarity of a tracking servo signal is reversed, a track blank is started, information can be played and it can do that there is nothing when equipped with the optical disc of the record type which copied this, it can apply also to a new anti-copying policy.
[0076][Embodiment 2] The 2nd example of this invention is continuously described using drawing 4. The thing of the character" mold [in / in the structure of the photodetector which receives catoptric light in this example / previous Example 1] of an abbreviated "rice field is an example which uses different things.
[0077]Generally in the optical pickup made combining each optic, the photodetector of an abbreviated "character of rice field" mold is used in many cases. Although explanation was omitted in the previous example, it is almost the case to use together the optical art which also generates a focus servo signal from the

photodetector of a this "character of rice field" mold in many cases, and is called astigmatic method in that case.

[0078]However, since this astigmatic method has a little sensitive adjustment of an optical system and there are also many mark of discrete part, an assembly and regulatory cost tend to become a little high.

[0079]On the other hand, a photodetector, the semiconductor laser which is light sources, etc. are accumulated into one package, the mark of discrete part are reduced and what made adjustment of the optical system easy is being used widely in recent years. This is called what is called a hologram laser unit, and makes a kind of diffraction grating called a hologram substitute for a part of optical system, It can generate from the output of the photodetector built in in it to reproduction of a focus servo signal, a tracking servo signal, and the recorded information signal.

[0080]Although drawing 4 is a block diagram of a main part at the time of applying this invention to generation of a tracking signal to the optical disk unit which uses what is called a phase contrast method, arrangement of the element of the photodetector 22 is not an abbreviated "character of rice field" mold, and it has become what changed a little. The name of the element of a photodetector is changed to a previous example.

[0081]Like [the photodetector 22 in this drawing 4] the 1st previous example, although it has the four elements a, b, and c and d, catoptric light is divided by the hologram which is the diffraction grating which carried out point **, serves as a fragment, and is condensed on each element. Although the elements a and b receive the portion which is equivalent to the front half of a scan and direction of movement of an optical beam among catoptric light, Since the above-mentioned hologram is designed so that the incident light quantity to both may change according to the gap of a focal position with an optical disc, a focus servo signal can be acquired from the output difference of these elements a and b. Although the elements c and d receive the portion equivalent to the rear half of catoptric light, since it is arranged so that the light by the side of the optical disc inner circumference side and a periphery may be received, respectively, a tracking signal can be acquired from these elements c and d by phase contrast method, the push pull method, etc. so that it may mention later. And total of the output of all the elements becomes a thing reflecting the information signal currently recorded on change of reflected light quantity, i.e., an optical disc.

[0082]Since what is necessary is just to search for the difference of its advance and scanning direction, and the light volume in the tangential direction of a pit sequence if it puts in another way among the catoptric light of an optical beam like point ** for acquiring a tangential push pull signal, In drawing 4, while asking for the output of the elements a and b which receive the catoptric light equivalent to a front half in the adder circuit 3-4, it asks for the output of the elements c and d which receive the catoptric light equivalent to a rear half in the adder circuit 3-3, and the difference of both added result is searched for in the difference circuit 12.

[0083]The adder circuit 4 which searches for the sum signal of light volume serves as connection which asks for a, b, c, d, and the four output sums like previous drawing 1.

[0084]On the other hand, in order to generate the tracking signal by a phase

contrast method, the adder circuit 3-1 seen by previous drawing 1 and 3-2 do not exist in this drawing 4. This is because the signal used for a phase contrast method is not acquired even if it uses the element a and the signal of b**, since the element arrangement of the detector 22 differs like point **. It can be said that in other words these elements a and b are elements arranged so that the intensity distribution which can set an optical disc radially among catoptric light may not be detected, and the elements c and d are elements arranged so that it can detect. The difference with the photodetector by which the element has been arranged at the character" mold of the abbreviated "rice field of such the point originates in having chosen arrangement suitable for building in a hologram laser unit and considering it as small element components as it was already described.

[0085]But since the phase contrast according to the relative position gap with an optical beam and a pit sequence will appear in those outputs if there is an output of two elements which is a radial direction of an optical disc and which receives the catoptric light of an inside-and-outside hoop direction, generation of the tracking signal by a phase contrast method is possible. Therefore, in this drawing 4, it has given the comparator 5-1 and 5-2 as it is, respectively, without adding the output of the elements c and d with others.

[0086]Since there are not what already explained the operation and timing in the circuit of drawing 4 in the previous example, and a change, it omits.

[0087]in addition -- if the photodetector 22 is observed -- this example -- the tangential direction of the inside of catoptric light, and a pit sequence, and the radial direction of an optical disc -- respectively -- abbreviation -- the element is arranged so that the intensity distribution of a parallel direction can be detected. the radial direction of an optical disc -- abbreviated -- detecting the intensity distribution of a parallel direction -- the element c. it is d -- the tangential direction of a pit sequence -- abbreviated -- detecting the intensity distribution of a parallel direction -- the element a. It is a pair of the elements c and d to the pair of b. For this reason, both a tangential push pull signal a signal required for a phase contrast method and the signal equivalent to total of reflected light quantity are generable from the output of a photodetector like the 1st previous example.

[0088]Since arrangement of the element is suitable for the hologram laser unit like the above-mentioned if reference is made, Pit depth will be detected also in the optical pickup miniaturized using this hologram laser unit, and the advantage of this invention which says the polarity of a tracking servo signal as change **** automatically can be enjoyed collectively.

[0089][Embodiment 3] The 3rd example that continues and starts this invention is described using drawing 5.

[0090]Although this example uses for the abbreviated "character of rice field" mold the photodetector by which the element has been arranged like the 1st previous example, it is not a phase contrast method and uses the push pull method for generation of a tracking servo signal.

[0091]In this drawing 5, a tangential push pull signal and the sum signal of reflected light quantity are searched for, the depth of a pit is detected and judged based on it, and there is no place which changes changing the switch 6 with the 1st previous example. The operation is also the same.

[0092]On the other hand, by this example, although a tracking servo signal is

generated, the thing using the push pull method is assumed as above-mentioned. The push pull method divides the catoptric light of an optical beam into the inner circumference [of an optical disc], and periphery side, and makes it a tracking servo signal in quest of the intensity difference.

[0093]Therefore, the element a which receives the ingredient by the side of the optical disc inner circumference of catoptric light by the adder circuit 3-1 in this drawing 5. While asking for the sum of the output of b, in the adder circuit 3-2, it has the composition of asking for the sum of the output of the elements c and d which receive the ingredient by the side of an optical disc periphery, and searching for the difference of both output swing in the difference circuit 17 without letting a phase comparison circuit pass. By LPF18, a difference result extracts the low-pass ingredient, and is outputted as a tracking servo signal.

[0094]Although the switch 6 is changed according to the depth of the detected pit, it is considered as the composition which changes the polarity at the time of connecting the adder circuit 3-1 and the output of 3-2 to the difference circuit 17 by this drawing 5. Of course, you may be the composition which forms inverting amplifier in the output of the difference circuit 17 separately, changes one side of the output of this and the difference circuit 17, and is made into a tracking servo signal.

[0095]Although the push pull method is used for generation of a tracking servo signal in this example, also in the optical disc in which the groove which is the guide rail which was not and continued was intermingled, a tracking servo signal is generable only according to a pit sequence by this push pull method.

[0096][Embodiment 4] The 4th example concerning this invention is described using drawing 6.

[0097]In this example, while using the photodetector which is not the character" shape of an abbreviated "rice field built in the hologram laser unit like the 2nd example, the case where the push pull method is applied to generation of a tracking servo signal like the 3rd previous example is assumed. The name of each element of the photodetector 22 is changed from the thing of the approximately "character of rice field" shape in the 1st and the 3rd example, and is made the same as the thing in the 2nd example.

[0098]In drawing 6, connection and operation of parts which search for the signal equivalent to a tangential push pull signal or reflected light quantity, and detect pit depth, such as the photodetector 22, the adder circuit 3-3, 3-4, the adder circuit 4, and a subsequent circuit, are the same as that of the 2nd previous example.

[0099]Connection of the elements c and d of the photodetector 22 differs, and it is connected to the difference circuit 17 through the switch 6, and has the composition that the difference of the output swing is searched for.

[0100]The push pull method divides the catoptric light of an optical beam into the inner circumference [of an optical disc], and periphery side, and makes it a tracking servo signal in quest of the intensity difference as it already stated when describing the 3rd example. As it stated when describing the 2nd example on the other hand, the elements c and d receive the portion equivalent to the rear half of catoptric light, but. Since it is arranged so that the light by the side of the optical disc inner circumference side and a periphery may be received, respectively, if the output difference of these elements c and d is searched for,

the tracking servo signal by the push pull method can be acquired the same with using the photodetector of an abbreviated "character of rice field" mold.

[0101]Although the switch 6 changes the output from the elements c and d in this example, the difference circuit 17 is given and the polarity of a tracking servo signal is changed, inverting amplifier is formed separately and it does not matter as composition of performing the change to the output of the difference circuit 17.

[0102]As it already explained in the 1st example, in this invention The diffraction direction of the catoptric light from a pit, As a result, it uses reversing the wavelength of the light (optical beam with which an optical disc is irradiated) which the intensity distribution changes with depth of a pit, and uses especially bordering on (lambda/4n), when the refractive index of the substrate of lambda and an optical disc is set to n. Although this thing is not stated separately, also in which example, it is a common principle.

[0103]However, by (lambda/4n), there is no depth which produces the inversion of this diffraction direction, and whenever the depth increases on the basis of this actually (lambda/2n), it exists. Therefore, when the refractive index of the substrate of lambda and an optical disc is set to n and arbitrary integers are set to k and m for the wavelength of the light of an optical beam still more generally, the depth of a pit is <(klambda/2n) D1< {(lambda/4n) + (klambda/2n)}. And {(lambda/4n) +(mlambda/2n)} <D2< {(m+1) -lambda/2n}

If classified into which group of D1 which fills ******, and D2, since it reverses between the pits belonging to these groups, the diffraction direction of catoptric light detects the depth of a pit, and the polar change of a tracking servo signal is possible for it.

[0104]Therefore, what is necessary is just to select k and m that it is easy to manufacture a direction with a certain amount of pit depth on manufacture of an optical disc, so that the condition may be fulfilled when there is a reason of **. Since there is no necessity that k and m take the same value, the flexibility at the time of selecting pit depth is large.

[0105]But what is necessary is for it to be [manufacture] easier for pit depth to stop at the necessary minimum depth, and just to set at least one side of the above-mentioned k and m to 0 generally, in that case, since it is said that the quality of the signal reproduced is good.

[0106]

[Effect of the Invention]The optical disk unit by the composition of the 1st means of this invention, Since a difference of the depth of a pit is detected and the polarity of a tracking servo signal is changed automatically, Since exact tracking servo control is possible and the depth of a pit does not change the polarity of a tracking servo signal to the optical disc whose number is one to the optical disc which has the pit formed in the different depth, it has compatibility also to the conventional optical disc.

[0107]The optical disk unit concerning the 2nd means of this invention detects the depth of said pit in the optical disk unit of the 1st means based on the polarity of the signal according to the difference of the intensity distribution in the tangential direction of a pit sequence in the change point of the signal according to the light volume of the catoptric light of the optical beam with which the pit sequence was irradiated. Since these signals are signals easily generable from an

optical pickup, there is no necessity of forming a new photodetector and sensors in an optical pickup, and they can distinguish the depth of a pit.

[0108]The optical disk unit concerning the 3rd means of this invention, In an optical disk unit given in the 1st means or 2nd means, the signal according to the difference of the intensity distribution which can be put on said tangential direction, and the signal according to the light volume of said catoptric light are binary-ized by a comparison means, and the depth of a pit is distinguished based on the change timing and the level of the signal. Therefore, most circuit means for pit depth detection can be integrated as digital IC, and it excels in fields, such as reliability, cost, a packaging area.

[0109]In an optical disk unit given in the 1st means, the optical disk unit concerning the 4th means of this invention generates a tracking signal by a phase contrast method, and it changes the polarity of a tracking signal according to the detection result of said pit depth detection means. Therefore, even if an object lens is displaced greatly, it is hard to produce offset to a tracking servo signal, and also since most is a digital circuit, a phase difference detecting means required for a phase contrast method can also attain integration of a circuit, and is excellent in fields, such as reliability, cost, a packaging area.

[0110]In an optical disk unit given in the 1st means, the optical disk unit concerning the 5th means of this invention generates a tracking signal by the push pull method, and it is characterized by changing the polarity of a tracking signal according to the detection result of said pit depth detection means. Therefore, also in the optical disc currently formed only by the pit sequence by intermingling the groove which was not and continued, a tracking servo signal is generable.

[0111]The optical disk unit concerning the 6th means of this invention, In an optical disk unit given in the 4th means or 5th means, said photo detector The catoptric light of said optical beam, the tangential direction of said pit sequence, and the radial direction of said optical disc -- respectively -- abbreviation -- since it has the arrangement which can detect the intensity distribution of a parallel direction, a signal required for detection of pit depth is appropriately generable.

[0112]In an optical disk unit given in the 6th means, since the optical disk unit concerning the 7th means of this invention is arranged in the shape of [of the abbreviated "rice field by which said photo detector is conventionally used abundantly in the optical pickup] a character", it can use the conventional optical pickup, without adding a new element.

[0113]setting the optical disk unit concerning the 8th means of this invention to an optical disk unit given in the 6th means -- said photo detector -- the radial direction of said optical disc -- abbreviated -- the element which can detect parallel intensity distribution, and the element which is not made are arranged. Since arrangement of this element is suitable for a hologram laser unit, it can attain the miniaturization of an optical pickup or a device using a hologram laser unit.

[0114]The optical disk unit concerning the 9th means of this invention, When the refractive index of the substrate of lambda and an optical disc is set to n and arbitrary integers are set to k and m for the wavelength of the light of said optical beam in the optical disk unit of the 1st means, The depth of the pit

formed in the shape of [to be used] an optical disc is characterized by being classified for any of D1 and D2 which fulfill the conditions of <(klambda/2n) D1< {(lambda/4n) + (klambda/2n)} and {(lambda/4n) +(mlambda/2n)} <D2< {(m+1) -lambda/2n} being. For this reason, the depth of a pit can perform the automatic change of a tracking servo signal, and the design flexibility at the time of optical disc manufacture increases.

[0115]The optical disk unit concerning the 10th means of this invention is characterized by setting at least one side of k of said integer, and m to 0 in the optical disk unit of the 9th means. For this reason, the time and cost of manufacture of an optical disc can be held down, and it is possible to make quality of the played signal high.

[0116]The optical disk unit concerning the 11th means of this invention is characterized by including information in the depth of said pit in the optical disk unit of the 1st means, the 9th means, or the 10th means. For this reason, the automatic change of the polarity of a tracking servo signal is performed, and the information according to the depth can be reproduced separately and improvement in storage density and additional information can be acquired from the pit of the object which performed that change.

[0117]The optical disk unit concerning the 12th means of this invention, In the optical disk unit of the 1st means, the 9th means, or the 10th means, When equipped with the recorded type optical disc which forms the recording mark which irradiates with light, and from which reflectance differs, it is characterized by choosing the depth of the pit of an optical disc so that the polarity of said tracking signal over this may turn into polarity which produces a tracking servo blank. Therefore, what copied unjustly the information on the optical disc which recorded information in the pit to the recorded type optical disc cannot perform tracking servo control normally, but since it cannot play information, it can be made into the prevention means of a copy.

[Translation done.]